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A Description of Caisson Work to Bed Rock in Chicago for Modern High Buildings.

By George Manierre.

It takes about three weeks to dig a caisson and two and one-half days to fill it with cement. This cement is made out of one part cement, two parts torpedo sand and four parts crushed stone. The time of excavating caissons varies according to what the stratas of the ground are composed of. The upper 85 feet is mostly of a plastic clay. Where plastic clay is, we dig eleven feet in eight hours. Where we come to hard clay and hard pan, five feet in depth will be eight hours' work.

The lower fifteen feet, just above rock, is sometimes a quicksand or boulder strata, filled with water, and it takes five days, working twenty-four hours a day, to get through this fifteen feet. The diameter of these caissons is usually seven feet. Most of the caissons in the central business district of Chicago reach rock at about 110 feet below sidewalk or inner grade. They are enclosed with hard wood lagging, 3″ thick, tongue and grooved. This lagging is from 3′ 6″ to 5′ 4″ long, and is put in place after the earth below has been dug out to a depth to correspond with the length of the lagging. The lagging is of different lengths, the shorter length, 3′ 6″, being used where the ground is very soft or where great weight is on the adjacent ground.

This method of making solid foundations for buildings has been in use only twelve years,* and was first used by Mr. Sooy Smith, an engineer of Chicago.

The blue clay, about fifteen feet below inner grade, is very hard, but after boring through we find it much softer, and this soft or plastic clay continues down to a depth of seventy feet below grade, when it changes to hard clay with gravel and small boulders mixed amongst it. In the early history of the city, when people had to dig wells, they went through the blue clay until they struck water mixed with gravel about 90 feet below the surface. There is no water laying above this.

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*This article was written April 19, 1912.

When the caisson is dug within a few feet of the solid rock we come across boulders that have distinct evidence of having been brought to their present position during the glacial period. The edges are all worn and other signs indicate this origin. These boulders are mostly of limestone, but here and there are granite boulders that have come from Wisconsin, and pieces of slate with veins of copper in it which may have come from Lake Superior. In closely examining the surface of the rock at the bottom of these caissons, one can notice the scratches or marks where the ice had been ploughing over it.

The apparatus that is used in excavating these caissons is an electric hoist with a tripod above, a hemp rope, and a steel bucket 20″ in diameter and 2′ deep, so constructed that it is easily emptied, being protected by a safety lock on the side, so that it is impossible for it to overturn in bringing the material up. The men go up and down to their work one at a time, standing in the bucket.

A caisson 7′ in diameter requires two men at the bottom digging, one man at the top, called a "signal man," who watches the bucket in its course of being hoisted, and his assistant, who empties the bucket and loads the wagon at the top. The tools used are shovels, pickaxes and mattocks or grubs. These mattocks have a face about 3½″ wide and are used in the hard clay with the boulders in it. The plastic clay is easily handled by the spade, but in the hard pan clay the mattock has to be used continuously.

The temperature in these caissons when 20 feet below grade is several degrees warmer in winter and cooler in summer than the outside atmosphere.

In the lower portion of the caissons, where there is water, the workmen have to use suits of waterproof material, so as to protect them from the seepage from the side of the well and from the buckets hoisting the water.

The water found in these caissons is hoisted to the top with the same electric hoist that takes up the excavated material and is hoisted at the same time as the other material found there. A bucket sometimes contains one-half gravel and the other half water.

This work has been found to be safe and healthy for the men. They see to work in these wells by electric lamps, which are lowered to them. The digging of these caissons has rather peculiar effects on adjacent buildings. Sometimes it is perfectly safe to sink them very close to a heavy wall, while at other times the sinking may be done with considerable danger to the property. This variation is caused by the condition of the sub-strata. The ground varies very much in a city block and in the sinking of one of these caissons, in going through the soft plastic clay, the adjacent buildings seem to sink as soon as this soft strata is being taken out, but the greatest danger to the neighboring wall comes from taking out the soil between caissons to make subbasements. This may endanger to a great extent the building which is near it. Under the present law the owner who is building these caissons is not liable for any damage done to the neighboring buildings, provided he has given due notice to the owners of his intention of sinking caissons and uses proper care in following up his work.

The cost of building one of these caissons as described above at this date is about $3,500.

In the excavation of a caisson, the following is the system adapted to keep it plumb from start to finish. In excavating a section deep enough for a set of lagging, which is usually 5′ 4″ long, the excavation at first is roughly done, the diggers keeping away slightly from all sides until they reach the depth mentioned above, 5′ 4″. At this depth a space in the bottom is cleared nearly level and of the entire area of the caisson. A heavy plummet on a fine line is dropped from the center mark at the top of the well and a stake is driven into this level bottom, which marks the center. Then a gauge stick, with this point as a center, gives the workmen the proper form for the lagging. They then trim the sides from the bottom up toward the former set of lagging and when the sides are trimmed properly the steel ring, which forms the inside brace of the caisson, is laid on top of this borrom and the process of setting up the lagging all around against the dirt takes place. There are two rings used for each set of lagging. When the lagging has been laid around the well the joining part where the laggings meet is wedged up tight with shingles, so that the lagging itself forms quite a strong wall of resistance against the outside pressure. The wooden lagging is nearly always left in the caissons now. Heretofore it was taken out and used over again, but it was found that considerable caving of the dirt into the cement filling took place during the process of filling and in such a manner that it was impossible to know whether it was caving in amongst the concrete or not, so it is deemed unsafe to take any of the lagging out.

The rings used as described above are made in two pieces, each one-half of a circle, and are bolted together when they are used down in the well, each half of the ring having lugs projecting about 3″ at right angles to the ring. Consequently each half is bolted to the other half through these lugs. Sometimes when the rings do not exactly fit the size of the lagging, we insert hardwood washers between these laggings which will extend the diameter of the rings from one to three inches, according to what is needed. In caissons where the material is of clay, these rings are taken out one by one ahead of the concrete filling, but where it is quicksand material all rings have to be left in.

About 97′ below the surface is found a body of boulders about 10′ deep and, except for occasional pockets of gravel, the spaces between these boulders are generally filled with water. The bottom of the caisson at this depth is found to be occupied by this boulder bed. The rock surface is found to be level. The boulders do not lie in a depression or valley in the rock and the caisson borings in this city (Chicago) have shown no cliffs or sudden changes of level in the rock surface. The boulder bed is practically level and its thickness uniform. Several caissons in different parts of the city which have struck this boulder bed are so distributed as to suggest that it is long, winding and narrow. The boulders are overlaid by a thick bed of sandy clay. The boulders are from 1″ to 2′ 6″ in diameter. The four foot space between the boulders and the rock surface is occupied by a typical glacial gravel clay. This boulder bed is a very unusual phenomenon, although similar deposits have been found elsewhere. It is probably a deposit left by the narrowest and most rapid portion of a sub-glacial stream, flowing under a strong head. The boulders are chiefly limestone, cherk (flint) and granite similar to some of the Wisconsin granite. It does not seem to represent a stream present before the glacial period and may represent a stream beneath the ice of the glacial period. Owing to the open character of this bed there is certainly a strong stream flowing there at present and consequently much water will be found in any caisson which strikes it.

There is no work in the erection of a modern building where it is more important to have an honest contractor than in the building of caissons. A firm like D. H. Burnham & Company and other prominent architects always have a superintendent day and night who watches the various portions of cement, sand and stone that are to form the concrete that is put into the caissons. Recently buildings have been known to sink on caissons, where on examination it was found that the contractor had not put in the proper quantity of cement.